Overview of the immune system

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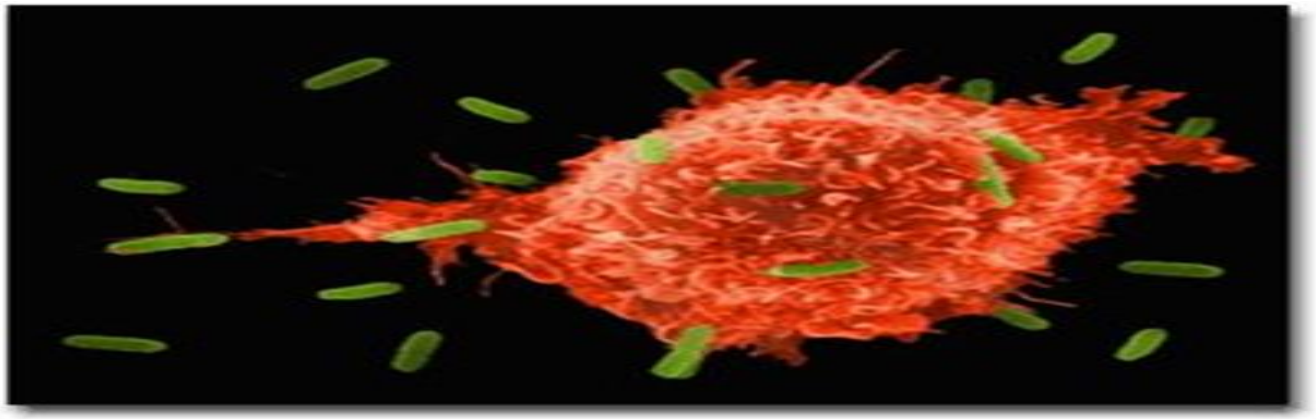
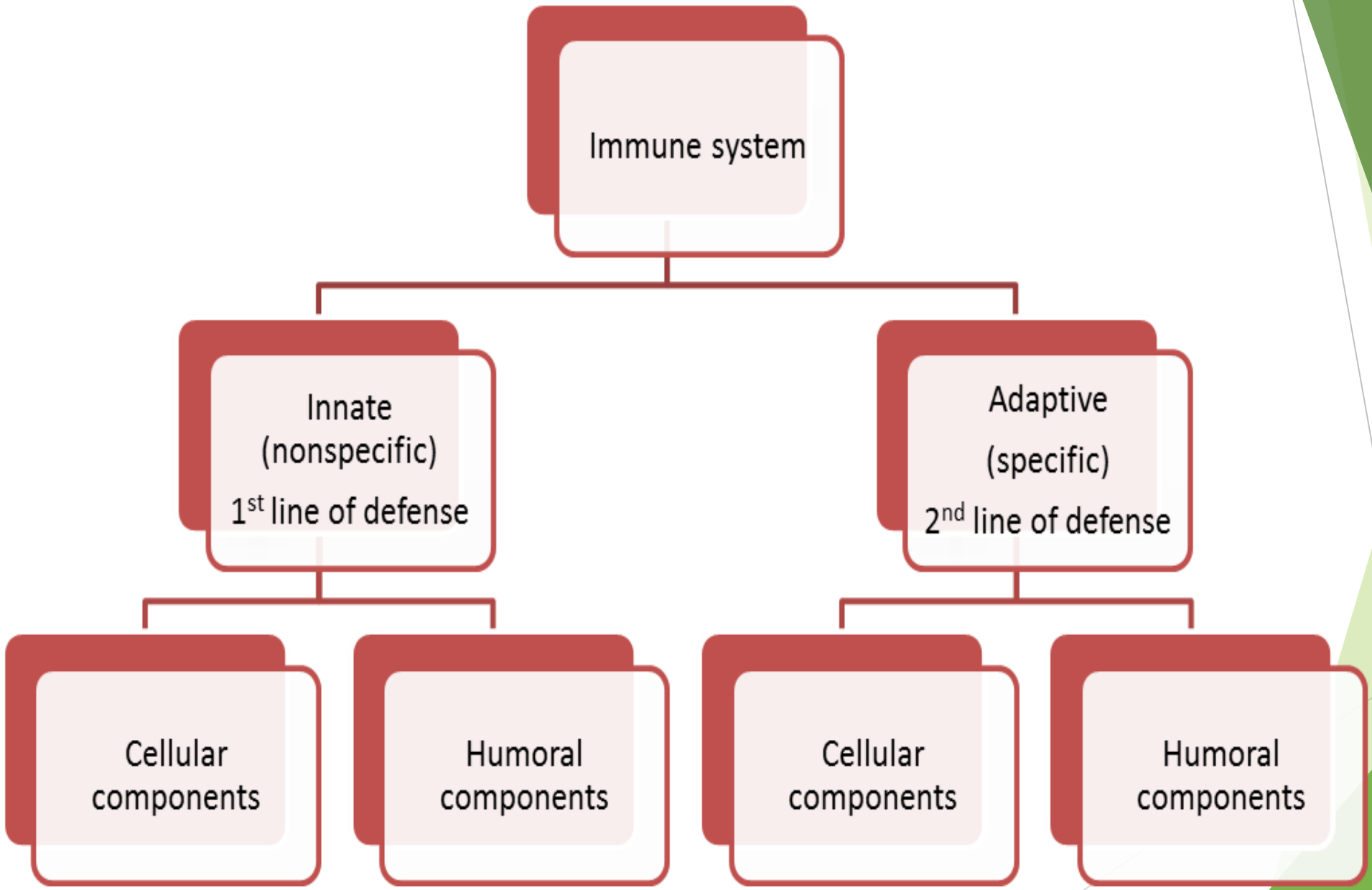


Why do we need an Immune System?

- Introduction:
- Pathogens: are microscopic organisms that cause disease (Viruses, Bacteria, Fungi, Parasites, and Protozoans).
- Environmental pathogens (poison ivy, etc).
- Toxins and Abnormal body cells such as cancers.

Where and how do we defend against disease pathogens?

- Immunity is :The ability to resist infection and disease Many body cells and tissues are involved in the implementation of immunity .
- Innate (Nonspecific) Defenses (we are born with this capability) Can involve the epithelium on the body surface (integument) or occur in connective tissue, in the GI system and/or may involve a cellular response
- Respond immediately to many different harmful agents
- Do not require a previous exposure to a foreign substance
- Adaptive (Specific) Defenses (these components develop with time)
- Lymphocytes (B, T, NK): Are major players in the immune response but other cells and participants in the innate system work cooperatively
- Identifies, attacks, and reinforces immunity to a specific pathogen


Immune system
Innate (nonspecific) 1st line of defense
Adaptive (specific) 2nd line of defense
Cellular components
Humoral components
Cellular components
Humoral components

Innate host defenses against infection

- Anatomical barriers
- Mechanical, chemical, biological
- Humoral components (Complement, coagulation system, cytokines)
- Cellular components(Neutrophils, monocytes & macrophages, NK cells, eosinophils)

Anatomical barriers- mechanical

System/Organ	Cell type	Mechanism
Skin	Squamous epithelium	Physical barrier Desquamation
Mucous membranes	Non-ciliated epithelium (e.g. GI tract)	Peristalsis
	Ciliated epithelium (e.g. respiratory tract)	Mucociliary elevator
	Epithelium (e.g. nasopharynx)	Flushing action of tears, saliva, mucus, urine

Anatomical barriers- chemical

System/Organ	Component	Mechanism
Skin	Sweat	Antimicrobial fatty acids
Mucous membranes	HCl (parietal cells), tears & saliva	Low pH Lysozyme & phospholipase A
	Defensins (respiratory & GI tract)	Antimicrobial
	Surfactants (lung)	Opsonin

Anatomical barriers- biological

System/Organ	Component	Mechanism
Skin and mucous membranes	Normal flora	Antimicrobial substances Competition for nutrients and colonization

Humoral components

Component	Mechanism
Complement	Lysis of bateria and some viruses Opsonin Increase in vascular permeability Recruitment and activation of phagocytic cells
Coagulation system	Increase vascular permeability Recruitment of phagocytic cells B-lysin from platelets – a cationic detergent
Lactoferrin and transferrin	Compete with bacteria for iron
Lysozyme	Breaks down bacterial cells walls
Cytokines	Various effects

Humoral components

- The complement system is the major humoral non-specific defense mechanism. Once activated complement can lead to increased vascular permeability, recruitment of phagocytic cells, and lysis and opsonization of bacteria.
- Cytokines : In response to microbes, dendritic cells, macrophages, and other cells secrete cytokines that mediate many of the cellular reactions of innate immunity .

Cellular components

Cell	Mechanism
Neutrophils	Phagocytosis and intracellular killing Inflammation and tissue damage
Macrophages	Phagocytosis and intracellular killing Extracellular killing of infected or altered self targets Tissue repair Antigen presentation for specific immune response
NK and LAK cells	Killing of virus-infected and altered self targets
Eosinophils	Killing of certain parasites

Phagocytosis and Intracellular killing Neutrophils and Macrophages

- As the microbe is being bound by the phagocyte's receptors and ingested, the receptors deliver signals that activate several enzymes in the phagolysosomes. One of these enzymes, called phagocyte oxidase, converts molecular oxygen into superoxide anion and free radicals. These substances are called reactive oxygen species (ROS), and they are toxic to the ingested microbes. (oxygen dependent pathway).
- A second enzyme, called inducible nitric oxide synthase, catalyzes the conversion of arginine to nitric oxide (NO), also a microbicidal substance (Nitric oxide dependent).

Innate Immunity: Inflammation

- Redness - increased blood flow
- Heat - increased blood flow and increased metabolic activity
- Swelling - increase in fluid loss – capillaries to interstitial space, capillaries become more permeable due to histamine and other chemicals
- Pain - stimulation of pain receptors from compression from interstitial fluid; chemical irritation by kinins, prostaglandins, microbe substances
- Loss of function - (may occur in severe cases)
- Acute inflammatory response
- a local, nonspecific response -- typically lasts 8-10 days
- sometimes persists in process of chronic inflammation

Defense Against Disease

Nonspecific External Barriers
skin, mucous membranes

If these barriers are penetrated,
the body responds with

Innate Immune Response
phagocytic and natural killer cells,
inflammation, fever

If the innate immune response is insufficient,
the body responds with

Adaptive Immune Response
cell-mediated immunity, humoral immunity

Specific defenses

- Specific defenses are those that give us immunity to certain diseases.
- In specific defenses, the immune system forms a chemical “memory” of the invading microbe. If the microbe is encountered again, the body reacts so quickly that few or no symptoms are felt.
- The major players in the immune system include:
- Macrophage
- T cells (helper, cytotoxic, memory)
- B cells (plasma, memory)
- Antibodies

TABLE I-3 Comparison of innate and adaptive immunity

	Innate	Adaptive
Response time	Hours	Days
Specificity	Limited and fixed	Highly diverse; improves during the course of immune response
Response to repeat infection	Identical to primary response	Much more rapid than primary response
Major components	Barriers (e.g., skin); phagocytes; pattern recognition molecules	Lymphocytes; antigen-specific receptors; antibodies

Table 1-3
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Vaccine Overview:

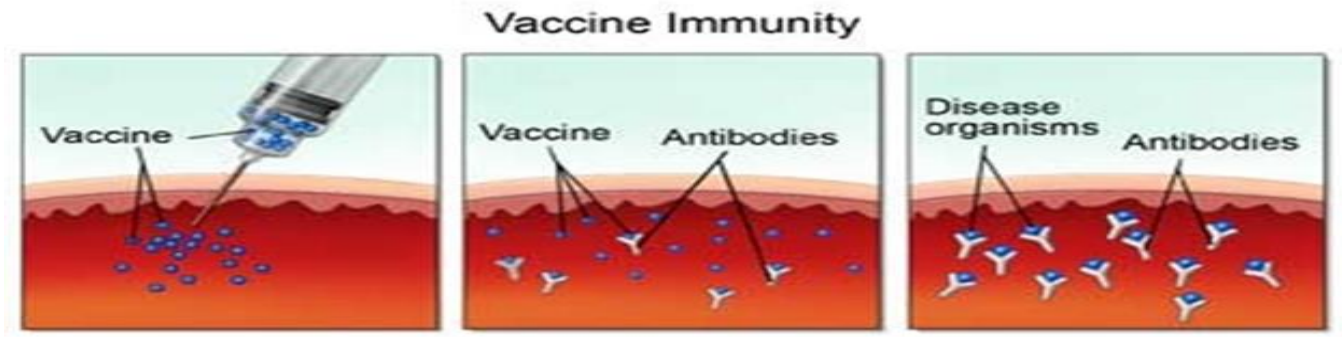
- A vaccine is a biological preparation that improves immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism, and is often made from weakened or killed forms of the microbe.
- Aims of Immunisation Programmes:

It is estimated that vaccination saves the lives of 3 million children a year

- **Eradication:** Infection (pathogen) has been removed worldwide e.g. smallpox
- **Elimination:** Disease has disappeared from one area but remains elsewhere e.g. polio, measles
- **Control:** Disease no longer constitutes a significant public health problem e.g. neo-natal tetanus

How vaccines work:

- Modern vaccines are created from killed bacteria or viruses, or fragments of proteins from these microbes.
- The proteins are recognized as antigens by our immune systems. This causes a mild immune response. Memory T-cells and B-cells remain ready to fight off the illness if it is encountered again.



Types of vaccines and their characteristics

- 1. Killed pathogen: heat or formalin (Salk polio vaccine)
- 2. Live-attenuated:selection of less or non pathogenic variants (Sabin Polio vaccine)
- 3. Subunit vaccine :•purified or genetically engineered structural component of a pathogen (Hepatitis B vaccine)
- 4. Secreted or extracted bacterial products toxoids:(are toxins inactivated by chemical treatment or induced mutation to be immunogenic but not pathogenic) ; cell wall polysaccharides
- 5. Conjugate vaccines : combination of multiple components to increase immunogenicity or memory induction
- 6. DNA vaccine :inject the gene that makes the protein


Thank you for
listening